GEOLOGY OF WAYNE COUNTY

BY

MELVIN F. AREY

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CONTENTS

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INTRODUCTION

LOCATION AND AREA.

Wayne, fifth from the east of the counties bordering upon Missouri, is next east of Decatur county, south of Lucas and west of Appanoose. The three upper tiers of civil townships are everywhere conterminous with the congressional townships. The four in the south tier are fractional, the three eastern townships of this tier lacking more than twelve sections and the fourth lacking a little less than twelve, owing to the fact that the boundary line runs a little south of west rather than upon a parallel of latitude. The county contains about 525 square miles. Agriculture is the chief industry, though the mining of coal engages no inconsiderable portion of the activity of its citizens.

PREVIOUS GEOLOGICAL WORK.

This county has received comparatively little attention from the geologists except as a coal producing region. White* has the northeastern limit of the Upper Coal Measures enter the county at the middle of its northern boundary, whence it proceeds to Centerville. Later investigations place this boundary of the Missouri stage, the more recent equivalent of the Upper Coal Measures, farther west, though its exact location is still somewhat uncertain. In discussing the practicability of prospecting for certain coal beds known to outcrop in Davis county and vicinity, White recommends sinking a shaft in the valley of Medicine river in case of successful results reached in the valley of the Chariton river, recommendations which are yet to be carried out, so far as the writer can learn.† In volume II of the present series of Reports‡ several pages are devoted to the coal outcrops and mines of the county. Hinds, in his report on the Coal Deposits of Iowa,§ has described the coal bearing

*Geol. of Iowa, White, Vol. I, p. 242, 1870.
†Ibid. p. 261.
‡Keyes: Iowa Geol. Surv., Vol. II, pp. 402-406.
§Iowa Geol. Surv., Vol. XIX, pp. 264-261. 1908.

strata and the mines of Wayne county. Incidental allusions occur in other volumes, but nothing that promises to give material aid in solving any of the numerous problems of geology has thus far been found.

PHYSIOGRAPHY

Topography

The surface of this county is a plateau having an elevation of a little over one thousand feet. Kansan drift originally thickly blanketed the older formations practically everywhere leaving a surface with comparatively little perceptible variation in elevation. Today much of this surface has suffered little change from erosion through the long interval since the disappearance of the ice sheet, though the material itself has weathered notably to some depth. While this plateau has been deeply and complexly dissected by the running waters, in two localities only has the underlying rock been exposed. It is true the streams are small, having their sources within the bounds of the county, with the slight exception of the Chariton river which barely cuts the northeast corner of the county. Yet the South Fork of the Chariton has excavated a valley more than a hundred feet deep through the major part of its course, finding the rock only in the last mile of its passage, in section 36 of Wright township.

Though erosion has proceeded until the ramifications of the main waterways have advanced well into the dendritic stage, yet only near the confluence of the larger branches have they succeeded in reducing the elevation of the interstream ridges. Every township has several areas of from one to several sections the original surface of which has never been materially modified. Varying little from one another except in size and outline, a journey over them would be very monotonous were it not for the absorption of the traveler's interest by the stacks of hay, thickly standing shocks of harvested grain, or other evidences of nature's bountiful response to the labors of the husbandman. These level tracts, however, are slowly but surely being encroached upon on all sides by the headward erosion of the numerous streamlets that in times of melting snows or heavy rains swell into raging torrents, the effectiveness of their erosive

Plate XX. Upper view—Rugged Kansan topography, east one-half section 7, Grand River township.
Lower view—Flat Kansan type of drift areas common in the county. Southeast quarter section 1, Grand River township.

power being greatly encouraged by the cultivation of the soil, leaving its surface bare of vegetation at the very time when these little streams are most active, since through a large part of the year they are wholly without water. If trees were allowed to grow along the sides of these intermittent waterways their ravages would be checked very materially, the effects of wind erosion would be reduced and the beauty of the landscape would be improved as well. In these times of quickening in-

Figure 16. Encroachment upon the unmodified drift topography by headward erosion of small intermittent streams. Grand River township.

terest in practical forestry and the immanence of a wood and lumber famine, a little care in the selection of the kinds of trees would further enhance the utility of such a course.

Three phases of topography here present themselves: one is the flat interstream areas just described, another is the flat bottom lands of the larger streams while the third includes the intervening territory, which consists of a succession of ridges and valleys, small relatively in the immediate neighborhood of the flat areas and gradually becoming steeper-sided and of

greater elevation and depression as the larger streams are approached. This phase, occupies, perhaps, the larger extent of the county. The flat bottom lands constitute the least area, being almost a negligible quantity compared with the others, and confined mainly to the valleys of the South Fork and its larger tributaries. The naturally wooded tracts are the bottom lands of the larger creeks and the rugged lands adjacent to them.

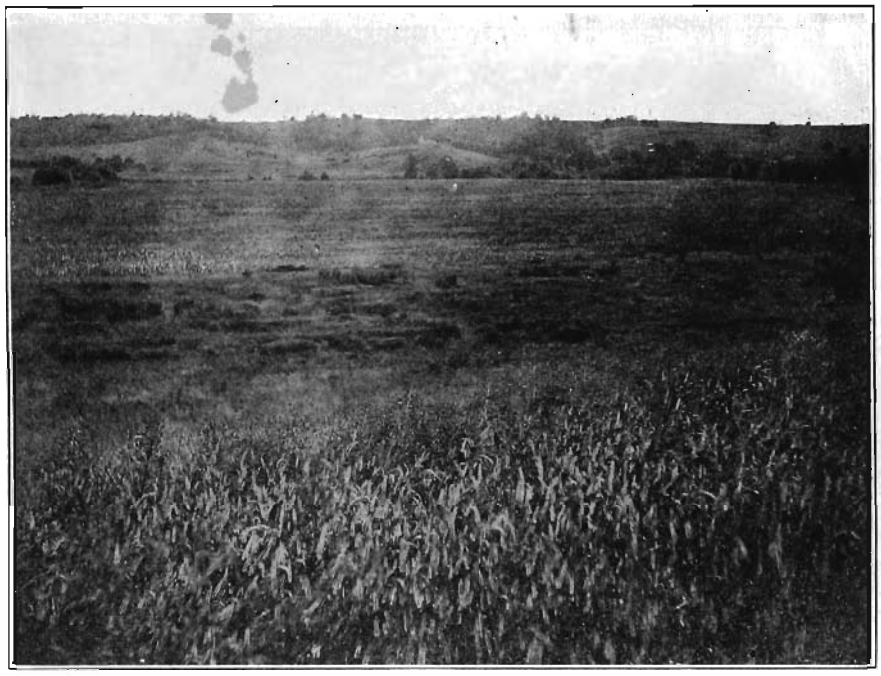

Figure 17. Flat bottom lands on Caleb creek, section 6, Grand River township.

There is little tangible evidence that preglacial topography has left any impress upon the present, if we except the slopes of the Chariton. Its channel doubtless is that of a pre-Kansan stream and it is not unlikely that the course of the South Fork in the main is over the buried channel of a tributary of the ancient Chariton, though it has not yet reached the bed of the former stream excepting in section 36 of Wright township. It is unlikely that so firm a rock as is here exposed has been cut away through a thickness of at least twenty feet in addition to at least a hundred feet of till in post-Kansan time while nowhere

above this point has erosion reached the rock surface. The present divide between the basin of the South Fork and that of the south flowing streams was left as a slight swell in the plateau surface, partly determined perhaps by the preglacial valley of the South Fork, though the records of the few prospect holes that we have secured would not indicate that there is much difference in the altitude of the subjacent rocks of the uplands and of the lowlands.

It is said above that the present topography is in part the result of erosion. The flat bottom lands are to some extent the product of aggradation. The smaller V-shaped valleys in their lower courses have been aggraded till they, too, have a flat bottom, though of restricted extent, the thickness of the deposit being ten or fifteen feet, sometimes. The material is mainly a heavy clayey silt, the recent wash from the neighboring hillsides, portions of the Kansan till one remove further towards its final destination, the sea bed. The bed of the stream of today is cut into this deposit and not infrequently through and beyond it, the excavated silt having been carried one and in some instances several removes further on its way.

From Gannett's Dictionary of Altitudes, fourth edition, 1906, we may compile the following table of altitudes for points in Wayne county:

TABLE OF ELEVATIONS.

STATION	AUTHORITY	FEET
Allerton	C., R. I. & P. Ry.	1130
Benton	C., B. & Q. R. R.	1059
Cambria	K. & W. R. R.	1100
Clio	C., R. I. & P. Ry.	1117
Corydon	K. & W. R. R.	1105
Harvard	C., R. I. & P. Ry.	1087
Humeston	C., R. I. & P. Ry.	1104
Kniffin	C., R. I. & P. Ry.	1086
Lineville, Mo.	C., R. I. & P. Ry.	1094
Promise City	K. & W. R. R.	1065
Sewall	C., M. & St. P. Ry.	1106
Seymour	C., M. & St. P. Ry.	1074

Drainage

The Chariton river, though itself practically extra-limital, controls the drainage of quite two-thirds of the county. The other third has no master stream, its water courses being merely the initial branches of small rivers that are tributary to the Missouri and have a southerly course. The largest of the latter streams has a length within the county of less than fifteen miles. Reckoned from the east, they are Locust, Fowler and Walnut creeks, Big, Middle and West Forks of Medicine river, Caleb and Steele creeks. These streams have little individuality except in trivial details. Caleb and Steele creeks, with a southwesterly course, make their way into Decatur county before discharging into the south flowing Weldon. For the most part they have the deep V-shaped valleys common to the upper courses of the streams of the Kansan drift regions. Caleb creek, the largest of these, has quite a wide alluvial bottom, well up into the county. They are all post-glacial, consequent streams, undoubtedly.

All along the north border a series of still smaller streams flow northward, tributaries of the Chariton. The South Fork of the Chariton is preëminently the master stream of the county, receiving the run-off waters of two-fifths of the county's area, though in common with all the others its sources are all within the borders of the county. Rising in Warren township, southwest of Allerton, its course is due north to a point in section 4, Benton township, whence its course is easterly, crossing the east line of the county in section 36, Wright township. Throughout its easterly course it has an alluvial bottom more than a mile in width in some places. Farther south Walnut, Cooper and Shoal creeks, smaller tributaries of the Chariton with easterly courses, drain portions of South Fork and Walnut townships.

It will be recognized that there are two swells in the drift mass constituting the surface of the county, which serve as divides; one passing east and west entirely across the upper tier of townhips in a sinuous line, turning the waters of the minor tributaries of the Chariton northward and those of the South Fork southward. The other and stronger begins, in common

with the first mentioned, in Richmond township and proceeds at first southeasterly though mainly southward, for some fifteen miles, then sharply turning winds its way eastward nearly to Seymour whence it runs southeasterly to the border. From the position of these divides the run-off waters are turned to every point of the compass. There is nothing about them, however, to distinguish them from the many others that separate the minor drainage basins, save their length and the fact that they give bounds to the basin of the master stream, the South Fork, excepting a small area of the eastern border north and south of Seymour which is included within their limits but is drained by direct tributaries of the Chariton.

STRATIGRAPHY

With one exception, of little importance beyond the fact that it is an exception, the Pleistocene alone appears as a superficial deposit within the limits of the county. Knowledge of the underlying formations must be sought, therefore, from the mines, prospect holes and deep wells that have penetrated the drift and entered the older beds somewhat. Outcrops in the adjoining counties also give some clue to the probable conditions in Wayne. The following table gives the relations of the various formations as they may be gathered from the above mentioned sources:

SYNOPTICAL TABLE.

GROUP	SYSTEM	SERIES	STAGE	FORMATION
Cenozoic	Quaternary	Recent	——————?	Alluvium
		Pleistocene	——————?	Loess
			——————?	Gumbo
			Kansan	Bowlder till
			Aftonian	Gravel, peat, silt
			Nebraskan?*	Dark bowlder clay
Paleozoic	Carboniferous	Pennsylvanian	Missouri	Bethany?
			Des Moines	Pleasanton
				Appanoose

*As a substitute for the non-geographical terms, pre-Kansan and sub-Aftonian, which have been used to designate the earliest sheet of drift in Iowa and states adjacent, Shimek proposes the name, Nebraskan. See Bulletin of the Geological Society of America, volume 20, page 408; published December, 1909. See also, SCIENCE, new series, volume XXXI, page 75, January 14, 1910.

CARBONIFEROUS SYSTEM

Of all the systems of the Paleozoic group in Iowa that are immediately overlain by the almost universally prevalent Pleistocene, the Carboniferous is by far the largest in area and of the greatest economic importance. Beginning on the northern border of the state with a width of eighteen or twenty miles, it rapidly extends eastward as its boundary is traced towards the south, reaching the Mississippi a little north of the mouth of the Iowa river. On the south border of the state it stretches from the Mississippi to the Missouri. Most of this extensive area is buried beneath heavy deposits of drift, sometimes reaching well nigh the maximum thickness of four hundred feet. Outcroppings are confined mainly to the banks of the deeply eroded channels of the larger streams and the lower courses of their tributaries. In Wayne county such exposures are limited to the scant mile of the course of the Chariton river and to a small tributary of it in the northeast corner of Wright township and to a half dozen miles or so along the South Fork of the Chariton and its tributary, the Little Walnut, in the northeast corner of South Fork and the southeast corner of Wright townships.

Of the two great divisions of the Carboniferous, the Lower has no practical significance in Wayne county beyond the fact that it lies below the beds in which there are any possibilities of finding coal, so that, if it is ever reached by the drill, further prospecting at the point where the drill is located, is absolutely unnecessary. But, as the later overlying deposits have never been penetrated as yet, and from all experiences and reasonable estimates in nearby counties, there are no undiscovered probabilities of profitable coal beds below these already known to exist, even this fact has little of economic interest. Bain,* with little reliable data and in the face of serious difficulties in determining just when the base has been reached owing to probable, but little understood, changes in the character of the uppermost rock of the Saint Louis stage, estimates that the base

*Iowa Geol. Survey, Vol. V, p. 376. Later developments have shown that the Saint Louis lies higher than this—from 350 to 500 feet below the surface—in central and western Appanoose and eastern Wayne counties. See also reports on Decatur, Wayne and Appanoose counties in volume XIX of this series of reports.

of the Coal Measures at Centerville is within about 600 feet of the surface. There is little likelihood that it is any less anywhere in Wayne county, but rather it is probable that the dip of the Lower Carboniferous strata continues towards the southwest, thus increasing their distance from the surface across the county from east to west. Moreover in the western part the beds of the Lower Coal Measures probably are succeeded by the over-lapping strata of the Missouri stage.

Pennsylvanian Series

DES MOINES STAGE

Appanoose Formation.

The outcroppings mentioned above belong to the Des Moines stage and with the evidences derived from deep wells, prospect holes and coal mines, establish the fact that the Pleistocene of nearly the entire county has immediately beneath it material belonging to the Des Moines stage. The terrane consists of sands, sandstone and shales more or less coherent, together with coal and limestones, all of which are usually quite variable as to thickness of beds, order of relationship and physical and chemical characteristics, though some of them maintain their identity over considerable areas, thus enabling the stratigrapher to determine with a reasonable degree of assurance the correct relationships of the more inconstant beds. In some localities the drift has never been penetrated fully and the underlying formation has been determined only by inference, but such are the grounds for the inference that it may be regarded as a fairly safe one.

The following section by Keyes* on Little Walker creek in the northeast corner of Wright township gives the character of the exposed beds in that locality:

		FEET	INCHES
7.	Drift	7	
6.	Limestone, blue, fossiliferous, thick bedded	1	8
5.	Shale, bituminous, fissile	1	4
4.	Coal	1	5
3.	Clay parting		2
2.	Coal		9
1.	Fire clay, gray, impure	2	

*Iowa Geol. Surv., Vol. II, p. 402.

The only other outcroppings in the county of Paleozoic material of any kind occur in the southeast corner of Wright township. The most important of these may be seen in a small quarry just east of the wagon bridge over Little Walnut creek in the south half of section 36, Wright township, and at the crossing of the South Fork of the Chariton river a little farther east. The quarry has merely broken into the level exposure to meet the very limited demand for stone for foundation walls, for which purpose it is said to be durable and otherwise very satisfactory. Loose stone lay heaped promiscuously in the quarry, concealing what little face it may have had, but from examination of the stone, it appears that the beds are irregular and from six to twelve inches thick. The rock at the quarry is hard, compact, bluish gray, brittle and with a conchoidal fracture, readily suggesting the lithographic type of the Cedar Valley limestone. At the South Fork crossing the rock has been used for the abutments of the bridge. The rock as exposed slopes from the river bed up into the road, a vertical distance of fifteen feet or more. It is yellowish brown and softer than the rock at the quarry owing to earthy impurities.

The remarkable thing about it is the unusual thickness of the deposit, as the limestones of the Des Moines stage are rarely more than three feet in thickness. There are no clay partings, though along the irregular horizontal division planes the limestone sometimes grades down into almost a shaly condition. The two phases of the rock maintain their distinctions very well. The conditions under which they were formed must have been very uniform and exceptionally extended in time. It would be of interest to know something more of the horizontal extent of this limestone. Its great thickness led to the supposition that it might be the Bethany limestone of the Missouri stage but this is disproved both by the stratigraphic and paleontologic conditions. The Joe Hayhurst mine, three-quarters of a mile to the northwest, has a depth of thirty feet. Its surface is unquestionably more than thirty feet above these outcrops. The mine of E. T. Jared, Jr., in the south half of section 26, has a total depth of only twenty-eight feet. The Simms mine, in the very northeast corner of section 1, South Fork township, is sixty

feet deep, but it is well up towards the prairie level, which in this locality is more than 100 feet above the bridge. Stratigraphically therefore, this limestone seems to lie below the coal bed that has been worked in the neighborhood.

Lees has suggested that it represents the "bottom rock" of these and neighboring mines. It does not appear that this rock has been penetrated in any of these localities and it is very probable that his suggestion correctly accounts for its stratigraphic relations. That it belongs to the Des Moines stage is assured from the fact that a specimen of *Spirifer rocky-montanus* Marcou, was found in the rock at the bridge, a brachiopod that is not found in the Missouri stage. The only other identifiable fossils discovered were *Seminula subtilita* Hall, *Dielasma bovidens,* and a spine of Archæocidaris sp.

Appanoose Beds.

Bain found in Appanoose county and extending over into Wayne county a well related group of strata forming a distinct substage of the Des Moines stage to which he gave the name Appanoose beds because of their widespread occurrence in that county. The most characteristic features of these beds are the Mystic coal seam and certain limestone bands which maintain a fairly definite and uniform sequence throughout the exposed portion of the area covered by them. From his study of numerous borings, shaft records, and exposures, he constructed a generalized section, a copy of which is here given:*

		FEET	INCHES
17.	Limestone, gray, subcrystalline, known among the miners as "floating rock"	2 to	4
16.	Shale, argillaceous, color variable	12 to	30
15.	Limestone, heavy ledges, the "fifty-foot limestone"	4 to	10
14.	Shale, argillaceous, blue and red in color	14	
13.	Shale, arenaceous, frequently forming a well defined sandstone	8	
12.	Shale, argillaceous, blue to gray	10	
11.	Limestone, somewhat variable in thickness, known as the "seventeen-foot limestone" or "little rock"	1 to	3
10.	Shale, sometimes gray, frequently bituminous and pyritiferous	7	

*Iowa Geol. Surv., Vol. V, pp. 382-383.

9.	Limestone, sometimes gray, and coarsely subscystalline; sometimes fine-grained, bituminous and grading into the shales above and below; known as the "cap-rock"	2 to 4	
8.	Shale, usually bituminous and known as "slate"; occasionally in part soft and clay-like, then known as "clod"; at times heavy and homogeneous, nonfissile, in which form it is known as "black bat"	1 to 3	
7.	Coal, upper bench, usually		8 to 10
6.	Clay parting, "mud band"		2 to 3
5.	Coal, lower bench, usually		8 to 10
4.	Clay parting, "the dutchman"		½
3.	Coal, frequently not so pure		2 to 3
2.	Fire clay	1 to 6	
1.	Limestone, "bottom rock"	3	6

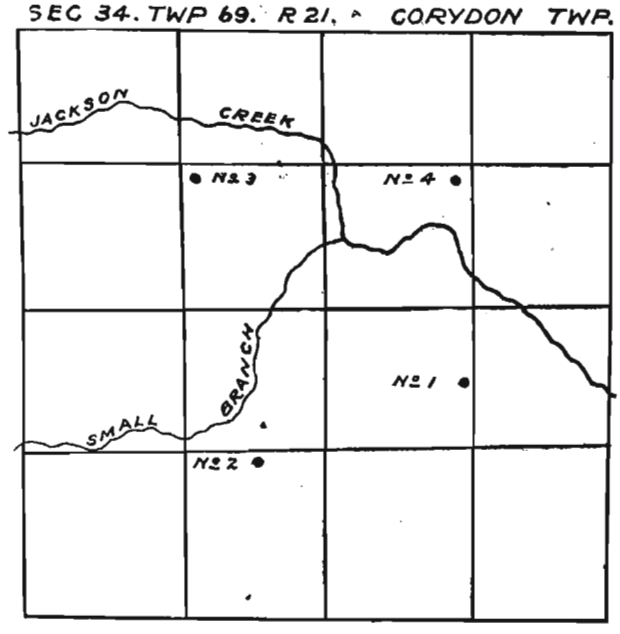

Figure 18. Plan showing location of Posten prospect holes.

The western border of these beds cannot be determined as yet with any degree of exactness owing to the fact that exploration into the Paleozoic formations in the west half of the county has been very seldom made and even when such explorations have been made definite records are not accessible. Mr. R. C. Posten has reported the results secured from three prospect holes drilled by him in section 34, township 69 north, range 21 west. Numbers 3 and 4 were on the creek bottom and at

about the same level and number 2, which was on a small branch was some fifty feet higher at the surface than the others.

PROSPECT HOLE NUMBER 2.

(Number 1 not accessible.)

Southeast quarter of the southwest quarter of section 34.

	FEET	INCHES
Surface, not characterized	25	
Sand and gravel	20	
Gray drift (144 feet, 8 inches total drift)	99	8
Gray shale	9	7
Red sand rock	1	4
Gray shale		6
Red sand rock		8
Light gray shale	3	6
"Soap" shale	23	11
Gray sand rock		8
Gray shale	3	6
"Soap" shale	2	
Red shale	1	
Light gray shale	15	6
Gray sand rock	1	4
Sand shale	3	8
Sand rock		6
Gray shale	6	4
Cap rock (limestone)	3	6
Gray shale	5	4
Light sand shale	19	6
Gray shale	23	7?
(1) Coal (at 270 feet, 7 inches)	1	5
Dirty coal		8
Gray shale	15	
Dark shale	4	
(2) Coal (at 291 feet, 8 inches)	1	2
Light shale	2	6
Rock, hard, hydraulic	3	6
Dark shale	4	6
Black slate	2	5
Gray shale	8	4
(3) Coal (at 314 feet, 1 inch)		9
Light shale	4	
Gray sand rock	1	2
Light sand shale	10	4
White rock	1	6
Gray shale	4	
Lime rock		8
Light shale	1	1?
Dark shale	3	
Dark sand rock		9
Dark shale	2	

(4) Coal (at 343 feet, 4 inches)		8
Clay parting		9
Coal		5
Dark shale, (sulphur)	6	6
Fire clay	7	2
Light sand shale	4	
Light sand rock	4	
Gray shale		10
Green shale		2
Lime rock		8
Light shale	1	5
Total	369	11

PROSPECT HOLE NUMBER 3.

(Southeast quarter of the northwest quarter of section 34.)

	FEET	INCHES
Surface	20	
Sand and gravel	15	
Gray drift and sand (total drift, 131 feet)	96	
"Soap" shale	5	6
Dark shale	3	6
Coal (No. 1), (at 140 feet)		3
"Soap" shale	16	9
Sand shale	6	
Fossil limestone	3	5
Light sand shale	16	
Gray shale	7	9
Black slate	2	
Gray shale	1	10
Coal (No. 2)		2
Fire clay	4	2
Hard rock, hydraulic	3	
Light sand shale	13	3
Light sand rock	2	
Dark shale	4	6
Light shale	4	
Light sand shale	22	
Gray shale	21	
Coal (No. 3)	1	3
Clay parting		1.5
Dirty coal		3
Coal		3
Light shale	1	
Gray sand rock	6	
Gray shale	13	
Dark shale	2	1
Coal (No. 4)	1	6
Dirty coal		2
Light shale	3	

Dark hydraulic rock	4	6
Dark shale	7	
Black slate	2	4
Coal (No. 5)	1	3
Light shale	1	
Hydraulic rock	2	6
Light sand shale	10	
Light shale	7	4
Dark shale	1	
Cap rock		8
Dark shale	2	
White top		8
Dark sand shale		8
Coal (No. 6)	1	
Dirty coal	1	11
Light shale	2	
Light sand shale	2	9
Gray sand rock	2	8
Light shale	1	6
Dark shale	2	
Black shale	1	2
Rotten coal (No. 7)		6
Dirty coal	2	1
Light shale	1	
Lime rock		10
Lime shale	4	1
Total	361	1

PROSPECT HOLE NUMBER 4.

Southwest quarter of the northeast quarter of section 34.)

	FEET	INCHES
Surface	18	
Sand and gravel	2	
Gray drift	68	
Water bearing sand	18	
Gray shale	32	
Black shale		6
Gray shale	1	6
"Soap" shale	53	3
Yellow clay shale	3	11
Black shale		3
Gray sand shale	2	7
Gray sand rock		4
Limestone, bastard	3	
Light shale	2	
Gray shale	6	1
Limestone	1	8
Light shale		6

Brown shale	1	
Dark shale	1	5
Brown rock		4
Light shale	1	
Light sandstone	8	9
Light shale	3	
Red clay shale	4	4
Light gray shale	5	4
Dark shale	1	
Gray shale	2	
Gray sandstone	5	
Gray sand shale	2	4
Gray shale	9	3
Red flint rock		4
Gray shale	11	
Dark shale		3
Coal (No. 1)		4
Coal, brown		8
Light sand shale	3	
Gray sand shale	4	
Gray sandstone	19	4
Dark shale	1	5
Coal (No. 2)	1	2
Dirty coal		8
Light shale	4	10
Lime shale	1	
Fossil limestone	1	8
Light gray shale	1	2
Dark shale	5	2
Gray sand rock		5
Gray shale		7
Black slate	1	
Coal (No. 3)	2	1
Fire clay	3	
Light sand shale	9	2
Hard gray sand rock	1	11
Sandstone	1	4
Light sand shale	7	2
Dark shale	3	8
Dark sand rock	1	3
Dark shale	3	2
Dirty coal (No. 4)		8
Light shale	2	
Dark shale, sulphur	5	4
Light sand	5	9
Sand rock	9	
Total	362	11

Comparison of these sections is interesting, for no side of the triangle formed by the location of these prospect holes is over a half mile long, yet each differs markedly from the others. There is fairly good correspondence between four of the coal seams, and in Number 4 the horizon of coal seams 1 and 2 of Number 3 is marked by a black shale or a black slate, but the number, sequence and thickness of the overlying, intermediate and subjacent beds are highly variable.

A comparison of these sections with Bain's generalized section in Appanoose county is interesting also. The most prominent differences are to be found in the number of coal beds, in the great prominence of arenaceous matter, either as sandstones or arenaceous shales, and in a corresponding lessening of calcareous deposits, the limestone beds being thinner and fewer in number, though in some instances they are represented by calcareous shales. These changes have somewhat obscured the evidence of the persistence of the Mystic seam in this locality, but a careful comparison and study of the sequence and character of the beds, makes it seem probable that bed 3 of Numbers 2 and 4 and bed 6 of Number 3, represent this seam. The presence of another coal seam below it is something of an anomaly to be accounted for by the fact that the Wayne county deposits were laid down near the border of the area where conditions were subject to change to an unusual degree. This view also accounts for the inferior quality of the coal in some of the thin veins as well as for the increased arenaceous and diminished calcareous constituents of many of the beds.

Pleasanton Shales.

Bain* found in Morgan township in the southeast corner of Decatur county certain shales immediately below the base of the Bethany limestone. These shales are more or less arenaceous and are sometimes associated with a limestone also usually arenaceous, which he believed to represent the top of the Des Moines. He thought them likely to prove equivalent to the Pleasanton shales of Kansas and in the interests of simplicity

*Iowa Geol. Surv., Vol. VIII, pp. 269-271.

of nomenclature he appropriated the name of the Kansas formation and tentatively applied it to the above mentioned shales in Decatur county.

In section 14, Richman township, Wayne county, the following beds were passed through as reported by McElhany Brothers, coal prospectors at Humeston.

		FEET
8.	Drift deposit	403
7.	Ferruginous shale	3
6.	Gray and yellow shale	4
5.	Dark blue argillaceous shale	11
4.	Variegated arenaceous shale with indented bands	7
3.	Gray sandstone	4
2.	Blue sand shale with sandstone partings	17
1.	Blue sandstone alternating with thin layers of blue, hard and impure limestone	55
	Total	504

This section, especially in the middle and lower beds, exhibits the characteristic lithological features of the so-called Pleasanton beds in Decatur county, being notably arenaceous and associated with sandstones and arenaceous limestones. The exceptional thickness is due to the lower sandstone beds which are themselves of unusual thickness.

These same beds may be recognized in Number 2 of the Posten prospect holes in Corydon township and possibly in the uppermost members of Numbers 3 and 4. There is no reason to question Bain's judgment that the drift of the western portion of the county is underlain immediately with these shales, but such is the great thickness of the drift, it is difficult to regard them as contributing in any degree to the prevalent superficial topography of this portion of the county, especially when it is taken into consideration that similar topography is not uncommon even as far east as Davis county. These topmost beds of the Des Moines manifest themselves along its border in Madison, Dallas, Guthrie and perhaps, Webster counties, but always exhibiting variations in the lithological character and the thickness of the individual beds, as well as in the thickness of the entire formation. Indeed in many localities exact discrimination between them and the related beds below is very difficult, if not quite impossible.

MISSOURI STAGE.

Owing to the great thickness of the drift, the absence of large streams that could cut through it and the fact that a sufficient water supply has been secured thus far without penetrating the drift, there is no available evidence that rocks of the Missouri stage underlie any part of the county's area, yet from the range of the border of that stage in counties north and west, it is not unlikely that the border line passes through the northern members of the western tier of townships.

QUATERNARY SYSTEM

Pleistocene Series

With two relatively unimportant exceptions in Wright township the entire county is overspread to a depth ranging from forty to more than 400 feet with material belonging to the Pleistocene. The Pleistocene of Iowa is made up of the morainic material of several distinct ice sheets and a number of secondary deposits bearing various names according to their positions and mode of formation.

NEBRASKAN STAGE.

This oldest of the ice sheets is often known in the state as the sub-Aftonian or pre-Kansan. It naturally follows from its basal position in the series, that it is rarely exposed except artificially, but in a few counties, along with overlying beds of other members of the Pleistocene, it has been revealed in railroad cuts in such a way as to leave no doubt of its true character and distinct nature. In other counties its existence has been made known only in sinking deep wells or in boring prospect holes and the like. In still others the evidence of it is so scanty that doubts may well be entertained that a correct interpretation of the phenomena under consideration would not ascribe them to the Kansan stage. Wayne county may well be classed here, for while the Nebraskan has its best expression in the southern counties, as a rule, this county has no natural exposures and few deep wells and the available records of borings through the drift give little ground for definite conclusions.

The old well at the Humeston creamery affords the following section approximately:

		FEET
12.	Surface	2 to 3
11.	Whitish clay, darker below	22 to 25
10.	Yellowish brown sandy clay	12
9.	Red sand	1
8.	Yellowish brown sandy clay	32
7.	Blue clay with trace of sand	34
6.	Yellow clay with fine gravel	35
5.	Blue clay	25
4.	White sand and gravel	3
3.	Blue clay and large gravel	30
2.	Blue mud	198
1.	Water bearing sand	8
	Total	406

From the section already given of a prospect hole in section 14, located only about a mile east of this well, it may be inferred that the water bearing sand in which the well ends is at the base of the drift. The blue mud may be Nebraskan and Number 4 may be Aftonian, though nothing given here except its position would indicate it. Allowing the surmise to be correct, the thickness of the Nebraskan is unusual for this neighborhood, but Macbride* reports its occurrence in Cherokee county with the surprising thickness of more than 500 feet, the Kansan on the other hand being very thin.

AFTONIAN INTERGLACIAL STAGE.

In the section given under the previous topic, Number 4 is referred hypothetically to the Aftonian. Numerous instances are reported currently of twigs, bogs and other vegetal remains and of black earth bands below the blue clay and in connection with sand or gravel aquifers. Inasmuch as the wells end in these water bearing sands nothing is known of the underlying beds. Mr. Alexander Mardis relates that in sinking a coal shaft at Corydon many pieces of wood of considerable size were found, real logs in some instances. These were met with at the base of the drift.

KANSAN STAGE.

After the Aftonian interval, the Kansan ice sheet made its way from the Keewatin center, ever widening its front and spreading over a broad expanse of country, including nearly the

*Geol. Surv. of Iowa, Vol. XII, p. 320.

whole area of Iowa. Upon its retreat it left a ground moraine usually of great thickness and having distinctive characteristics now well known and readily recognized by every student of the Pleistocene. Its components, as might be expected from the manner of its production, consist of fragments of the country rocks over which it swept with irresistible force. The greater amount of these fragments was ground into rock flour. In addition there are present the products of the Nebraskan glacial activities which often had been modified by the agencies which were active during the Aftonian interval. All these have been intermingled and blended in every conceivable manner and degree, and yet, different as it must prove to be upon close examination in different localities, whether near or remote, this material always preserves its general appearance and character. Two general phases are recognized: the normal unweathered basal portion, and the superficial phase, distinct enough when the two are noted at points separated vertically by a band of indistinct demarcation a foot or more in thickness. The difference has been produced by weathering agencies through the very long interval that has elapsed since the Kansan ice sheet laid down its burden, when it began its retreat northward. The changes were wrought chiefly by oxidation, leaching and removal of various mineral salts by plant growth. The material of the unweathered zone is of a dark blue color and is very dense and readily separable into square blocks owing to its finely jointed structure. In the superficial zone the color ranges through the yellow and red browns, owing to the oxidation of its iron constituents. It has lost much of its compactness also, and its granitoid pebbles and bowlders show a tendency to crumble and waste.

The few cases in which the thickness of the drift could be secured are here given. The Chicago, Rock Island and Pacific railroad well just over the state line at Lineville ends in loose stone at a depth of eighty feet, but other wells in the vicinity having a depth of fifty feet end in the drift. The prospect holes in Corydon township already given in detail show the drift there to be 106, 131 and 144 feet deep, the difference being due mainly to the difference in surface elevation. Mr. Alexander Mardis

reports 350 feet of drift before reaching a clay shale in a drill hole near the center of the southeast quarter of the northwest quarter of section 19, township 69, range 21 west, though three-fourths of a mile northeast, Mr. J. S. Whittaker reports it to be but .131 feet thick. A prospect hole near Humeston gives 403 feet of drift.

Rock was reached at 140 feet in a drill hole in the southwest quarter of section 22, Union township, the location being on a hillside, not far from the top. In the northeast quarter of section 14, Jackson township, the drift is sixty-three feet deep at an elevation some forty feet below the maximum for that vicinity. At the coal mine in the southwest quarter of section 23, Wright township, it is forty-five to fifty feet thick in a depression somewhat as in the last named instance. In section 36, Wright township, it is about 100 feet thick. The prospect hole already referred to east of Humeston is 403 feet deep and is entirely in drift. The sharp contrast in the two quotations at and near Corydon indicates the possibility of the existence of a buried channel there, but in the absence of other data nothing more could be determined. The shallowest drift occurs in the northeast and southwest corners of the county, while it is thickest in the northwest.

SECONDARY DRIFT FORMS.

Gravels and Bowlders.

Besides the sands and gravels that occur in sheets, streaks and pockets in the till and also the beds of these materials in the Des Moines and Missouri stages, occasional outcroppings in the road cuts were seen that readily suggest the Buchanan gravels so common in many of the more northern counties, particularly those within the Iowan drift area. On the hill in the road north of the Caleb creek bridge in section 31, Jefferson township, and also on a hill slope farther south in Grand River township such gravel outcrops occur. They are red brown in color, show marked indications of weathering and have similar relations to the Kansan till with the Buchanan gravels. Similar outcrops, though less ferruginous, were seen in Jackson township. In the southeast quarter of section 35, Wright township, two to three feet of gravel of this nature underlies the loess, which here is quite thin.

It is more than probable that some, if not all of these sand and gravel sheets, are residual in origin. Calvin* in his report on Page county describes similar beds, which he accounts for very satisfactorily as being the product of erosion where currents of sheet-water too weak to transport the coarser constituents of the till had removed the finer portions and thus caused an accumulation of gravel. It is difficult, however, to account for the thicker beds of Wayne county in this way, unless it be added that stronger local currents here and there moved such accumulations for a short distance and dropped them upon a slackening of the current in comparatively thick deposits.

Pebbles, cobbles and bowlders are comparatively scarce as seen in the road cuts. Bowlders are rarely seen in the fields. The largest was noted in section 24, Benton township. It had been partly uncovered in excavating the roadway and was six feet in diameter, though it had been broken up somewhat, being a weak sandstone. The distribution of bowlders was apparently very uniform over the county.

GUMBO.

Gumbo is a term often used in Missouri, Nebraska and in many of the southern counties of Iowa. Its application is somewhat varied, but this is warranted in great part on account of the variability of the material itself. It occurs overlying Kansan till and most frequently beneath the loess, but Udden notes it naturally exposed in some of the creek valleys of Pottawattamie county. Graduating as it often does into the loess above it and resembling it in many particulars it has been regarded by some as a form of loess, but sometimes it as certainly graduates into the bowlder clay below and in intermediate forms it maintains a distinctive character that justifies giving it a name and characterization of its own. Its color varies from a dark blue through the red and yellow browns to a drab. It consists of a dense, sticky and very impervious clay with scattered pebbles and coarse sand grains in the lower part. It is nonfossiliferous and well leached, though Bain finds small lime balls to be quite abundant in it. The exceptional thickness of forty feet

*Geo. Surv. of Iowa, Vol. XI, pp. 442-444.

has been given, but more commonly it does not exceed ten feet.

While its origin is still quite problematical, there is a marked tendency to consider it an aqueous product formed under different conditions and thus giving rise to the different phases under which it appears to-day. Udden* says "Probably it is mostly an old loess, which has been clogged up by interstitial deposition of fine ferruginous material through the agency of ground water. Perhaps it is in part a fluviatile deposit, made at a time of semi-stagnant drainage, or possibly it is of varied origin, being in some places a surface wash, or a disintegration product derived from the underlying bowlder clay, and at other places a modified upland loess, or a river silt." The open-minded attitude taken by this author upon the question of the origin of gumbo is undoubtedly the wisest until fuller details have been secured.

In Wayne county gumbo occurs over considerable areas of the flat-Kansan that are slightly basin-shaped, where its presence in wet seasons works more or less disaster to the growing crops by reason of its impervious nature, a condition which artificial drainage by open ditch canals or tiling would probably relieve.

LOESS.

In common with much of the Kansan drift area in southern Iowa, Wayne county has its uplands overspread to a large extent with a fine clayey silt which in this county is of a light gray color. It does not seem to be very thick anywhere, varying from a few inches to about two feet. Along the eastern sections of Walnut and South Fork townships, sometimes both it and the gumbo are wanting, the yellow Kansan till making the surface. At times the loess appears here, but gumbo fails to intervene. Usually gumbo immediately underlies the loess. Modified by plant action and tillage it constitutes the soil of much of the county. The black loam so characteristic of the Iowan drift region is seldom seen upon the uplands of the county.

A few sections made by the road cuts are here given. On the hillside west of the South Fork of the Chariton between sections 21 and 16, Benton township, is seen:

*Iowa Geol. Surv., Vol. XI, p. 258.

		FEET	INCHES
4.	Loess, light gray		8
3.	Clay, reddish brown, grading below into No. 2	2	
2.	Clay, yellowish	2	
1.	Clay, light brown with lime spats and balls, streaked, jointed and containing near the base, gravel and a few pebbles and cobbles, among which greenstone, quartz and the granitoids, were dominant		8

Numbers 2 and 3 are gumbo, but number 1 was believed to be Kansan till, though not quite typical in some of its features.

North of Lineville a roadside cut shows:

		FEET	INCHES
3.	Loess, light gray		6 to 8
2.	Clay, red-brown, plastic	2 to 3	
1.	Clay, light colored, mottled and streaked with iron and containing lime balls	3	

Number 2 is gumbo and so, possibly, is number 1. By reason of the grading of the gumbo into the till it becomes difficult to draw the line sharply between the two materials. The upper part of number 1 is much like gumbo while the lower part is much more like the till. Number 1 of the first section presents something of the same difficulty.

A more anomalous section occurs in section 32, Jefferson township, just north of the Caleb creek bridge.

		FEET
3.	Soil, fine, gray, somewhat gravelly	1
2.	A stiff, dark gray joint clay (gumbo)	1
1.	A stiff, light gray clay with some sand and gravel	2

Recent Series

ALLUVIUM.

Rich alluvial deposits cover the flood plain of the South Fork of the Chariton and extend a short distance up its larger tributaries. Alluvium is also found along Caleb creek and a few other streams. Along the eastern half of the course of the South Fork, these plains are from one to two miles wide, but elsewhere they are usually quite restricted. Most of the drainage of the county is accomplished by small post-glacial streams that have as yet merely cut V-shaped valleys that make deposits of any kind impossible.

ECONOMIC GEOLOGY

Soils

The chief natural source of wealth in Wayne county in the future as in the past lies in its soils. Loess, alluvium, gumbo and modified Kansan till constitute the principal kinds. Fortunately gumbo, the least desirable of these, is known mainly as a subsoil. Though in places it is all too thin, the most widespread of these soils is loess and happily, it is one of the best. The alluvium, too, ranks high for many purposes, but owing to its location it is subject to serious flooding in wet seasons. Where the loess is thin, the impervious nature of the gumbo is a detriment both in wet and dry seasons, holding the water upon the surface in wet seasons and preventing free capillarity in dry times. The former evil may undoubtedly be remedied by judicious drainage and where the gumbo is thin, tillage will tend to mingle better elements with it and thus make it more pervious. The till is perhaps more variable in quality than any of the others, and for this reason needs to be especially studied by the agriculturist, that he may get the best results from it, but upon the whole it is entitled to rank high in possible productivity. While the immediately available resources of Wayne county soils are gratifying, it is the opinion of the writer that scientific farming has many pleasant surprises in store for the land holders.

Coal

Next in value to the soils of Wayne county are its deposits of coal, which are found at various points in the eastern half of the district. There is little reason to doubt that the famous Mystic vein in workable conditions underlies a large part of this area, but profitable mining has been developed as yet in Wright, Walnut and Jackson townships only.

Along the Chariton river drift mining has been engaged in to some extent for a number of years. In sections 23, 26, 35 and 36, Wright township, a good quality of coal is mined to supply local demands, but owing to lack of good transportation facilities extensive operations cannot be engaged in profitably.

FEET	INCHES		
28		11.	Drift.
3		10.	Limestone, gray, thinly bedded.
3		9.	Shale, firm, bituminous.
3	5	8.	Shale, clayey, dark drab.
4		7.	Shale, light gray to blue.
4		6.	Limestone ("cap rock").
1		5.	Shale, drab, clayey "clod"
	10	4.	Shale, black, fissile.
2	6	3.	Coal.
1	6	2.	Fire clay, impure, gray.
2		1.	Limestone, gray, fossiliferous.

Figure 19. Section of old Frye shaft, Confidence.

In the southwest quarter of section 23, Mr. Lewis Frye has worked a twenty-eight inch vein for five years. Two to four inches of clay forms a parting about midway of the vein. Six or eight inches of slate make a good roof. Coal is found at a depth of 105 feet. Not far away John Kersey and John Hayhurst work a similar vein. The output of each of these mines for the year 1908-9 was about 45,000 bushels.

FEET	INCHES		
1		7.	Shale, bituminous, fissile.
1	8	6.	Coal.
	2	5.	Clay parting.
	7	4.	Coal.
	½	3.	Clayey parting, containing much pyrite.
	1	2.	Coal.
1		1.	Fire clay, impure.

Figure 20. Coal seam in Frye mine Confidence. After Hinds.

In the south half of section 26 at a depth of twenty-eight feet the same vein has been worked by E. T. Jared, Jr. The output of the Joe Hayhurst mine, in the center of section 35, is about 25,000 bushels. The vein is found at a depth of thirty feet. The Sipes mine, seventy-five feet deep, yields about 30,000 bushels annually. The conditions of all these and of some neighboring mines, some of which are worked only at intervals, are much the same. The seam maintains a uniform thickness of twenty-eight inches with very great persistency. The differences of depth are due to surface elevation. In the Simms mine, in the extreme northeast corner of South Fork township, the vein is reported to be thirty inches thick and at a depth of sixty feet.

In the southwest half of section 23, Jackson township, there is a coal shaft 165 feet deep, with a twenty-six inch vein and a good roof. Mr. W. R. Slack, the owner, reports an output of eighty bushels per day.

In the northeast quarter of section 14, same township, Thomas Wood operates a mine with a twenty-five inch seam, at a depth of 135 feet. The roof is said to be poor. Seven to ten tons per day is reported to be the output, the demand being local merely.

By far the greater part of the coal mined in Wayne county is taken out by the two mines of the Numa Block Coal Company at Seymour. Mine No. 2 is situated on the north side of the Chicago, Milwaukee and Saint Paul railway, one mile east of the Milwaukee depot at Seymour (southwest quarter of the northeast quarter of section 13). This mine, known as the "Big Jim," has produced more coal during recent years than any other in the Appanoose-Wayne coal field. Working full time it can easily produce 100,000 tons per year. It is equipped with an Ottumwa first-motion hoisting engine, steam dirt dump, Ottumwa box-car loader, and self-dumping cages. The remainder of the equipment is good. The shaft is 202 feet in depth. Mine No. 3, called the "Sunshine" mine, is in the southeastern part of Seymour about one-half mile from the Rock Island station. It loads a considerable output on the Chicago, Rock Island and Pacific railway. The shaft is 240 feet deep, showing that the strong south-

westerly dip seen in the mines is continued between Nos. 2 and 3. The lower part of the section in this district, as given by Keyes, is:

FEET	INCHES		
1	10		8. Limestone, gray, fossiliferous (exposed).
	6		7. Clay, drab, shaly ("clod)"
	10		6. Shale, bituminous, fissile.
1	4		5. Coal.
	2		4. Clay parting.
	9		3. Coal, with an occasional thin clay parting.
1	3		2. Fire clay.
1	10		1. Limestone, thick bedded, gray.

Figure 21. Part of Seymour shaft, Seymour.

In the northeast quarter of the southwest quarter of section 29, Walnut township, is the Winger mine. The shaft is 145 feet in depth. Hoisting is done by a small single engine. The limestone "cap rock" occasionally rests directly on the coal; elsewhere "slate" intervenes as shown in figure 22.

FEET	INCHES		
3			6. Shale, black, fissile, grading into 5 below.
1	2		5. Coal.
	2		4. Clay parting.
	8		3. Coal.
2	6		2. Fire clay.
3			1. Limestone, gray.

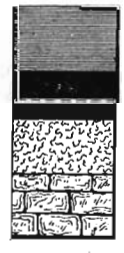

Figure 22. Bed of Winger mine, Harvard.

A number of other mines in different localities are reported to have been abandoned or to be worked at irregular intervals as they supply local demands only.

Numerous prospect holes have been put down. In some instances no coal was found, either because they were situated outside of the Des Moines area or because they were not carried to a sufficient depth. In many cases a good vein of coal has been reported to be found, but for various reasons it has not been worked as yet. Too much water, poor roofs, or too great depth are the commoner reasons given. Towards the western edge of

the Des Moines stage the Mystic seam appears to become more variable and other veins appear. The Posten sections already given illustrate this. In one of these as many as seven coal seams are found.

Mr. Alexander Mardis found a thirty-one inch vein at a depth of 321 feet in the northeast portion of the city of Corydon. In sinking a shaft, just before reaching the rock surface, a flood of water caused abandonment of further effort. This strong aquifer was the Aftonian doubtless, as numerous evidences of vegetation were found immediately above it.

Mr. O. C. Davidson some time ago had a prospect hole put down near New York, Union township. It is 200 feet deep and a good vein of coal is reported to have been found by Mr. Davidson, but details could not be secured.

Coal is reported to be found in Missouri three or four miles southwest of Lineville, but no active mining operations were discovered. Two thin seams of coal are reported in a prospect hole not far from the Mineral Spring about two miles southwest of Lineville. Along a "branch" southeast of the mineral spring near Dan Reagan's a very hard, thick bedded brown limestone some six feet thick outcrops. It overlies twelve to fourteen feet of blue argillaceous shale, locally known as soapstone. Somewhere beneath this a drift mine is said to have been operated. From inquiries made it is not thought that it is a very important outcrop. A prospect hole in the southwest quarter of section 21, Grand River township, 154 feet deep, failed to reveal any traces of coal.

Clays

Loess quite often proves to be a satisfactory material for brick making for common use. In the west border of Corydon Mr. Alexander Mardis has a brick plant where all the common brick used in that town are manufactured. Two or three inches of surface are removed and about eighteen inches of loess remain suitable for the purpose. Handmade brick of a good red color are made in quantity to meet the local demand and also to supply neighboring towns to some extent. The same material is used at Allerton, Lineville and Crawfordsville. The soft mud process is employed in all cases. The clays of the Des Moines stage would make excellent material for brick and tile

in some cases, no doubt, but the demand at present does not warrant the expenditures necessary to secure them, owing to the heavy covering of Pleistocene.

Water Supplies

Good water is usually secured in abundance from wells, dug, bored or drilled, ending usually in the drift, but in a few cases going to a sandy or gravelly aquifer just at the base of the drift and in a few instances ending in the older formation. At Seymour wells average from twenty-five to thirty feet in depth. At Corydon they are from twenty-six to thirty feet. At Humeston the average is twenty feet. About New York dug or bored wells average sixty feet. At Lineville dug wells average twenty to thirty feet. All were of this kind until a few years ago, when boring became common and some wells went to the depth of sixty feet, ending in the drift, however. The railroad well there is eighty feet deep, ending in rock, but the water is mineral to such an extent as to be of no value to the railroad company. The well just east of the public square is thirty-two feet deep and furnishes an abundance of water.

A well drilled in a deep valley two or three miles southwest of Lineville across the Iowa border reached limestone at twenty-seven feet. Shale, "soapstone" and sandstone are also reported but the driller was unable to give the details of the order or thickness of the various beds. The waters are strongly mineral and medicinal and a sanitarium is maintained there. The instances given are typical and illustrative for all parts of the county.

Mr. J. S. Whittaker informs me that fifty years ago water was scarcely obtainable from wells at any reasonable depth. Water therefore was run into dug wells from the roofs and such were called overshot wells. But these wells, forty-five to sixty feet deep, gradually acquired water by seepage until now it stands in them to within ten or fifteen feet of the surface. This change is due, perhaps, to the cultivation of the soil by which it has been rendered more pervious through the breaking up of gumbo and mixing in more pervious materials, such as loess and till, and thus allowing a higher per cent of the rainfall to become ground water.

Springs

Springs are rarely found anywhere in the county, but in the neighborhood of Humeston "made springs," as they are called, have been formed by piercing the foot or more of impervious clay underlying small bogs.. A water bearing sand is thus reached and a perennial spring or shallow artesian well is the result. On section 22, Richman township, near the line of section 21, a constant flow filling an inch and a quarter pipe has been secured. Others are located on sections 18 and 19.

White* gives a history of "salt springs" in Iowa. Of the twelve reputed salt springs given in a list supplied by Col. C. C. Carpenter at the time when he was Register of the State Land Office, one was located in section 1, township 70, range 22, Wayne county. Mr. J. S. Whittaker, one of the earliest settlers of the county, and one who has an intimate acquaintance over all parts of the county, finds no trace of a spring of any kind in that or neighboring sections. Long time residents of that immediate neighborhood know nothing of such a spring. Some of the springs in the list were real springs and maintain a briny taste to this day, but it will have to be conceded that the one in Wayne county was mythical from the first.

ACKNOWLEDGMENTS

The writer here wishes to express his grateful appreciation of the many courtesies extended to him in the prosecution of his work. He feels under special obligation to R. C. Posten, Esq., J. S. Whittaker, Esq., and Hon. Alexander Mardis, of Corydon, and Mr. Austin of the Lineville Tribune, who have given much valuable information and have otherwise shown a generous interest in the furtherance of the work.

*Geol. of Iowa, Vol. II, p. 335. 1870.

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF WAYNE COUNTY, IOWA.

BY

M. F. AREY.

1910

Scale 1/125000

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

R. XXIII W. R. XXII W. R. XXI W. R. XX W.

T. 70 N. T. 69 N. T. 68 N. T. 67 N.

RICHMAN WASHINGTON UNION WRIGHT

CLAY BENTON CORYDON SOUTH FORK

JEFFERSON WARREN JACKSON WALNUT

GRAND RIVER CLINTON HOWARD MONROE

Humeston, Cambria, Ovid, New York, Bethlehem, Confidence, Bentonville, Lewisburg, Sazon, Corydon, Bridgeport, Promise City, Allerton, Harvard, Seymour, Kniffin, Biggspring, Hodge, Sewal, Clio, Warsaw, Clinton Center, Genoa, Lineville

LEGEND

GEOLOGICAL FORMATIONS

PENNSYLVANIAN

MISSOURI

DES MOINES

INDUSTRIES

COAL MINES ■

CLAY WORKS ▲

QUARRIES ⚒

IOWA LITHO. CO.

DRAWN BY F. C. TATE